

## LOW DISTORTION DOWN-CONVERTER + AGC AMPLIFIER + VIDEO AMPLIFIER

### DESCRIPTION

The  $\mu$ PC3228T5S is a silicon bipolar monolithic IC designed for use as IF down-converter for digital TV, digital CATV. This IC consists of AGC amplifier, mixer and video amplifier.

The package is 32-pin plastic QFN (Quad Flat Non-lead) package suitable for surface mount.

This IC is manufactured using our 30 GHz  $f_{max}$  UHS0 (Ultra High Speed Process) silicon bipolar process.

This process uses silicon nitride passivation film. This material can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

### FEATURES

- Total performance :  $I_{CC} = 85$  mA TYP. @  $V_{CC} = 5$  V
- AGC AMPLIFIER + MIXER + DRIVER BLOCK :  $f_{RF(BW)} = 20$  to 800 MHz  
 : CG = 28 dB TYP.  
 : GCR = 70 dB TYP.  
 :  $IM_3 = 47$  dBc MIN./57 dBc TYP. @ Single Ended-OUT =  $0.5 V_{p-p}/tone$
- VIDEO AMPLIFIER BLOCK :  $G_V = 59$  dB TYP.  
 :  $f_{IF(BW)} = 20$  to 100 MHz  
 :  $IM_3 = 45$  dBc MIN./55 dBc TYP. @ Output = 110 dBu/tone, Differential-out
- High-density surface mounting : 32-pin plastic QFN package ( $5.0 \times 5.0 \times 0.75$  mm)

### APPLICATION

- Digital CATV
- Cable modem receivers

### ORDERING INFORMATION

Part Number	Order Number	Package	Marking	Supplying Form
$\mu$ PC3228T5S-E2	$\mu$ PC3228T5S-E2-A	32-pin plastic QFN (Pb-Free)	C3228	<ul style="list-style-type: none"> <li>• Embossed tape 12 mm wide</li> <li>• Pin 8,9 face the perforation side of the tape</li> <li>• Qty 2.5 kpcs/reel</li> <li>• Dry pack specification</li> </ul>

**Remark** To order evaluation samples, contact your nearby sales office.

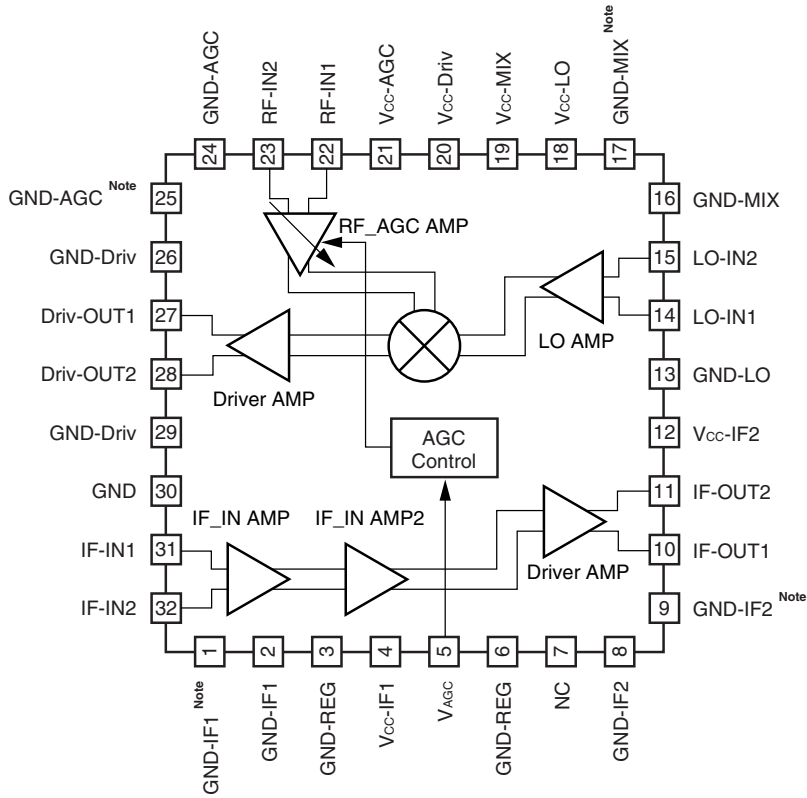
Part number for sample order:  $\mu$ PC3228T5S

**Caution** Observe precautions when handling because these devices are sensitive to electrostatic discharge.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.  
 Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

INTERNAL BLOCK DIAGRAM AND PIN CONFIGURATION

(Top View)



**Note** 1, 9, 17, 25-pin: Connected to the lead frame.

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C	6.0	V
Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = +80°C <b>Note</b>	800	mW
Operating Ambient Temperature	T <sub>A</sub>	<b>Note</b>	-20 to +80	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

**Note** Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

**RECOMMENDED OPERATING RANGE (T<sub>A</sub> = +25°C, unless otherwise specified)**

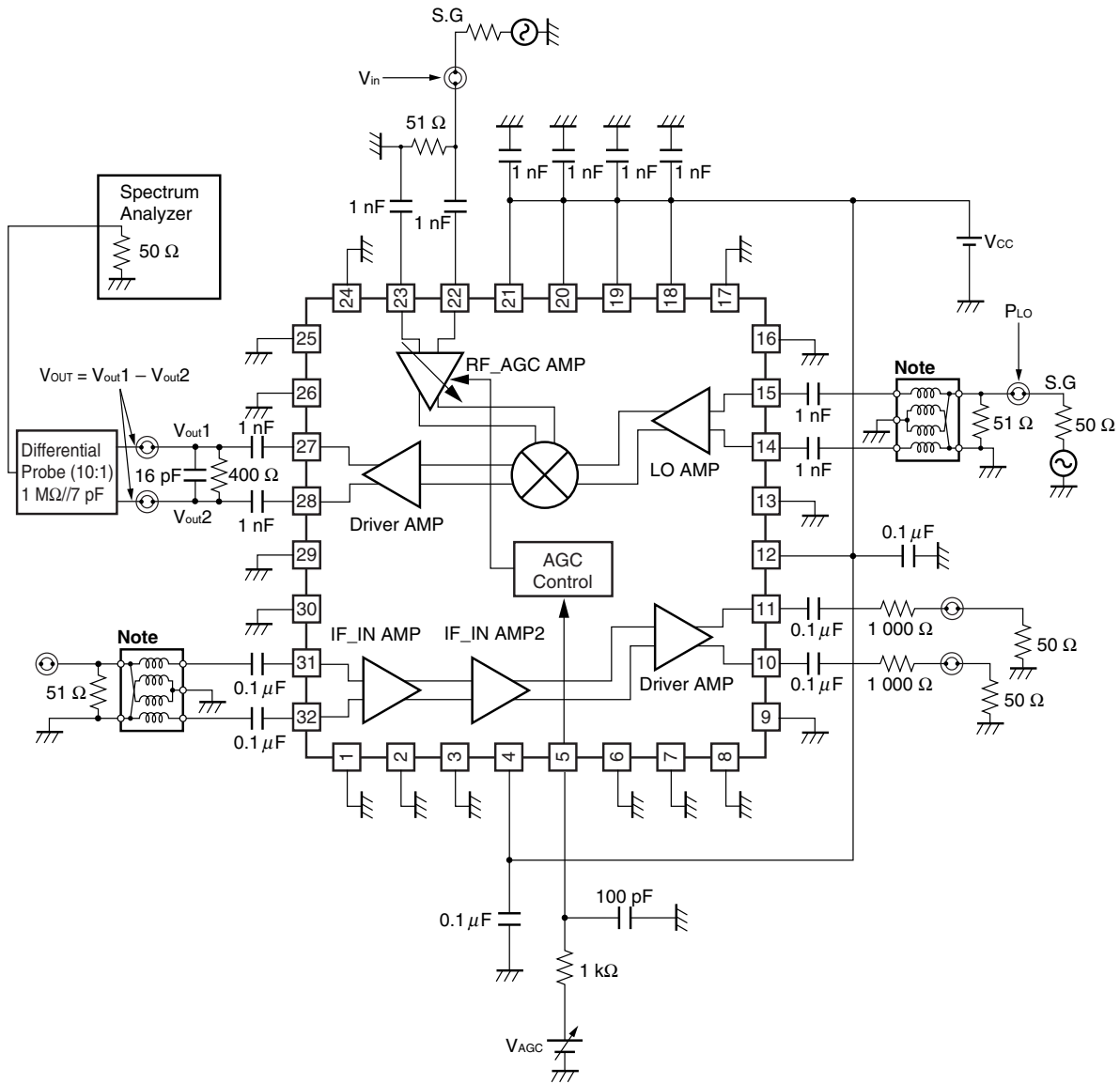
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sub>CC</sub>		4.5	5.0	5.5	V
Operating Ambient Temperature	T <sub>A</sub>	V <sub>CC</sub> = 4.5 to 5.5 V	-20	+25	+80	°C
Gain Control Voltage Range	V <sub>AGC</sub>		0	-	3.3	V
RF Operating Frequency Range	f <sub>RF (BW)</sub>		20	-	800	MHz
IF Operating Frequency Range	f <sub>IF (BW)</sub>		20	-	100	MHz

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5 V, unless otherwise specified)**

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
<b>DC Characteristics</b>						
Circuit Current	I <sub>CC</sub>	No input signal <b>Note 1</b>	65	85	110	mA
AGC Voltage High Level	V <sub>AGC (H)</sub>	@ Maximum gain <b>Note 1</b>	2.5	–	3.5	V
AGC Voltage Low Level	V <sub>AGC (L)</sub>	@ Minimum gain <b>Note 1</b>	–	0	–	V
<b>RF Characteristics</b> (RF AGC Amplifier Block + Mixer Block + Driver Amplifier: f <sub>RF</sub> = 80 MHz, f <sub>LO</sub> = 130 MHz, P <sub>LO</sub> = –10 dBm, Z <sub>S</sub> = 50 Ω, Z <sub>L</sub> = 400 Ω/16 pF)						
RF Input Frequency Range	f <sub>RF</sub>	f <sub>C</sub> = –3 dB <b>Note 1</b>	20	–	800	MHz
RF Gain Control Range	GCR1	V <sub>AGC</sub> = 0 to 2.5 V <b>Note 1</b>	62	70	–	dB
Mixer Conversion Gain	CG	V <sub>AGC</sub> = 2.5 V Differential-IN: V <sub>in</sub> = +18 dBmV <b>Note 1</b>	25	28	31	dB
3rd Order Intermodulation Distortion	IM <sub>31</sub>	f <sub>1</sub> = 44 MHz, f <sub>2</sub> = 45 MHz, V <sub>in</sub> = +30 dBmV/tone, Single Ended-OUT = 0.5 V <sub>p-p</sub> /tone <b>Note 1</b>	47	57	–	dBc
Noise Figure	NF1	V <sub>AGC</sub> = 2.5 V, f = 50 MHz, Differential-Output <b>Note 2</b>	–	8.3	–	dB
<b>IF Characteristics</b> (IF Amplifier Block + Driver Amplifier: f <sub>IF</sub> = 50 MHz, Z <sub>S</sub> = 50 Ω, Z <sub>L</sub> = 2 100 Ω)						
IF Input Frequency Range	f <sub>IF</sub>	f <sub>C</sub> = –3 dB <b>Note 5</b>	20	–	100	MHz
IF Amplifier Gain	G <sub>V</sub>	V <sub>in</sub> = –7 dBmV, Differential-IN/OUT <b>Note 5</b>	56	59	62	dB
3rd Order Intermodulation Distortion	IM <sub>32</sub>	f <sub>1</sub> = 49.5 MHz, f <sub>2</sub> = 50.5 MHz, V <sub>out</sub> = 110 dBu/tone, Differential-IN/OUT <b>Note 5</b>	45	55	–	dBc
IF Output Voltage	V <sub>out</sub>	Single Ended-Output <b>Note 5</b>	–	1.0	–	V <sub>p-p</sub>
Noise Figure	NF2	V <sub>AGC</sub> = 0 V, f = 50 MHz, Single Ended-Output <b>Note 2</b>	–	3.0	–	dB
<b>Total Block (RF AGC Amplifier + Mixer + Driver Amplifier + SAW Filter + IF Amplifier + Driver Amplifier), SAW Filter : EPCOS X6889M (f<sub>IF</sub> = 49 MHz, P<sub>LO</sub> = –10 dBm, f<sub>RF</sub> = 70 to 130 MHz, Z<sub>S</sub> = 50 Ω, Z<sub>L</sub> = 1 050 Ω)</b>						
LO-RF Leakage	LO <sub>RF</sub>	V <sub>AGC</sub> = 2.5 V, 22-pin 75 Ω Termination f <sub>LO</sub> = 110 to 180 MHz <b>Note 3</b>	–	–54	–44	dBmV
LO-IF Leakage	LO <sub>IF</sub>	V <sub>AGC</sub> = 2.5 V, V <sub>out</sub> = 0.7 V <sub>p-p</sub> Single Ended-Output f <sub>RF</sub> = 130 MHz, f <sub>LO</sub> = 179 MHz <b>Note 4</b>	–	–40	–25	dBc

- Notes 1.** By measurement circuit 1  
**2.** By measurement circuit 2  
**3.** By measurement circuit 3  
**4.** By measurement circuit 4  
**5.** By measurement circuit 5

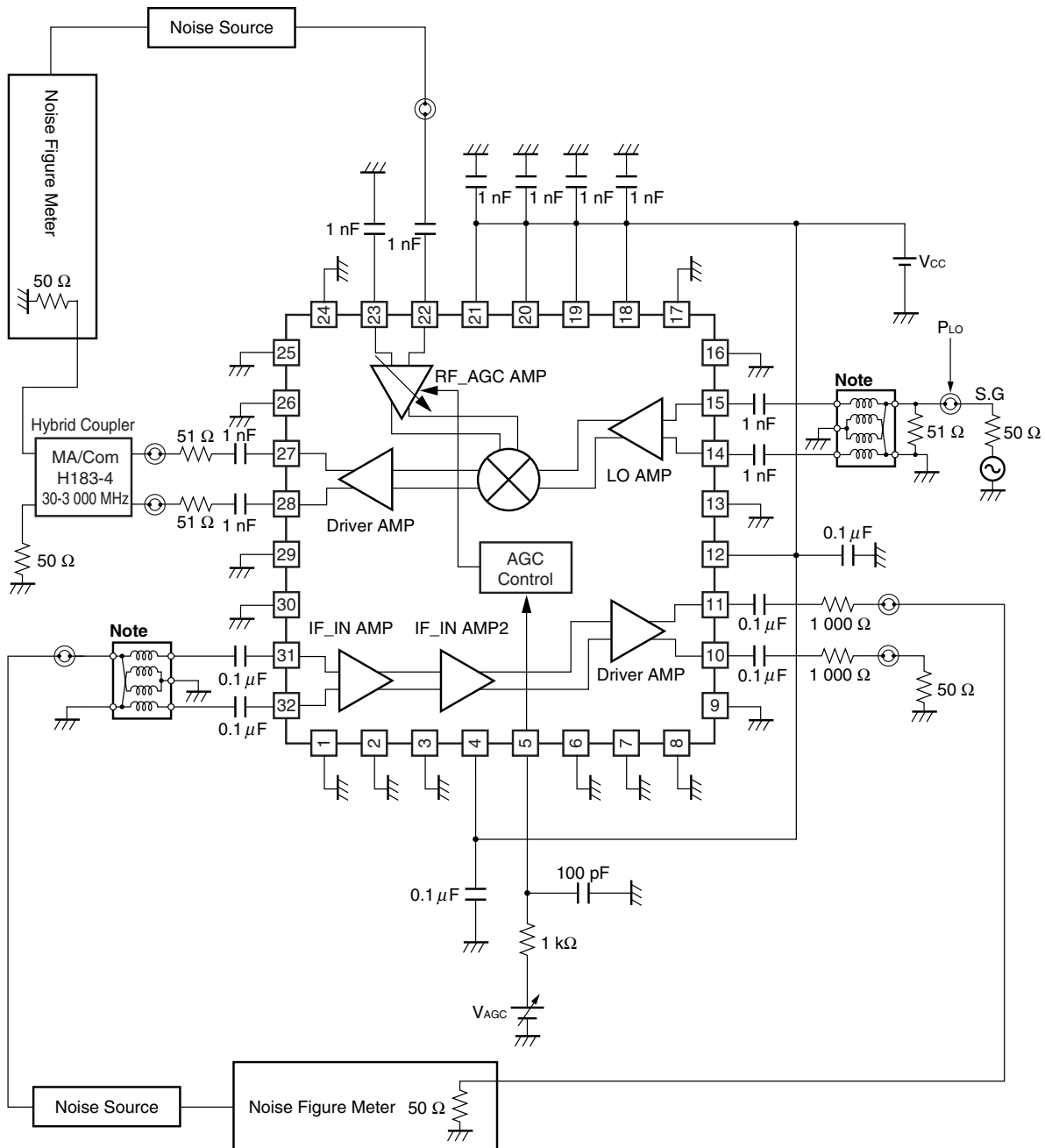
MEASUREMENT CIRCUIT 1



**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)

MEASUREMENT CIRCUIT 2

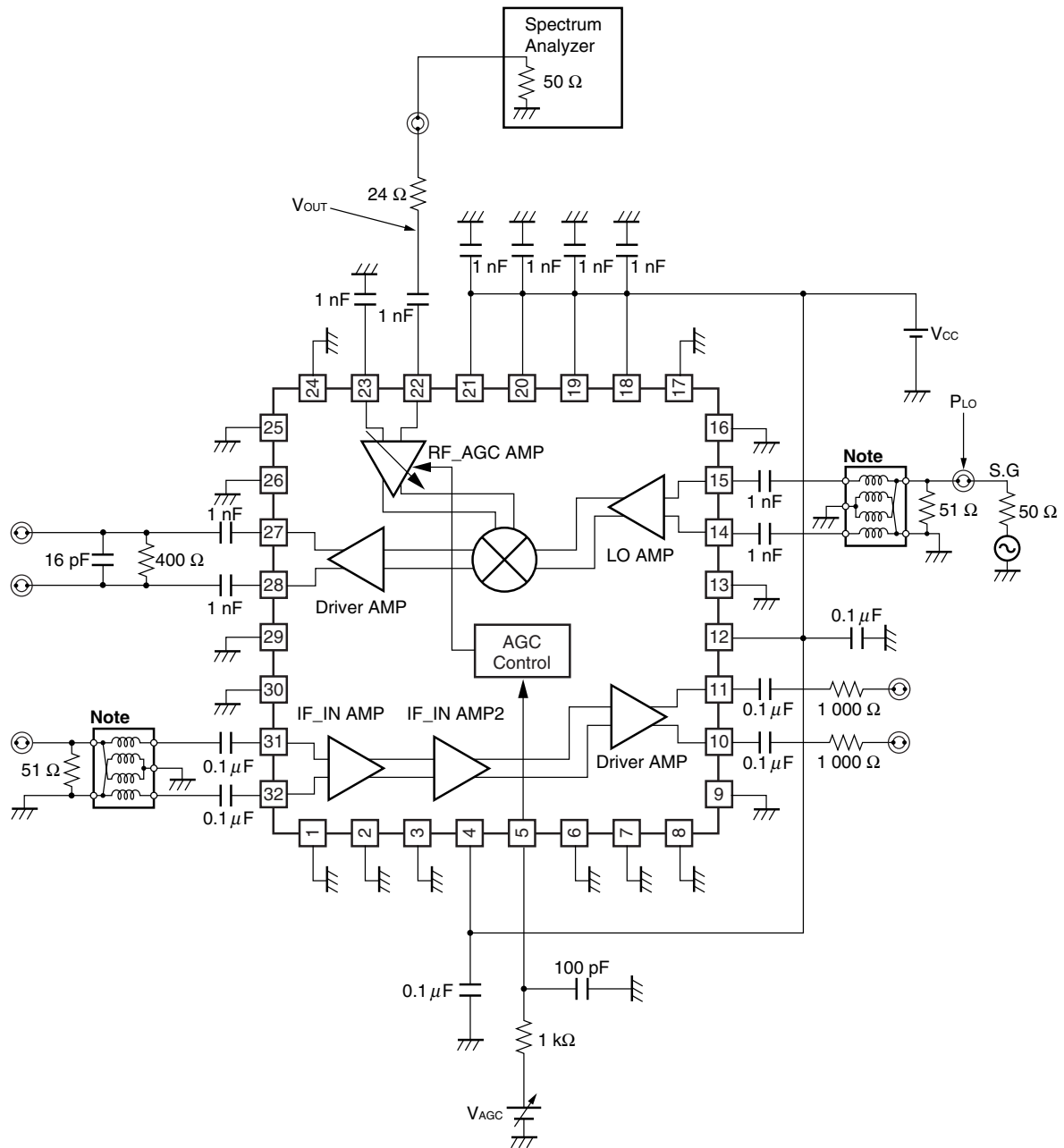
Noise Figure



**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)

MEASUREMENT CIRCUIT 3

Lo-RF Leakage

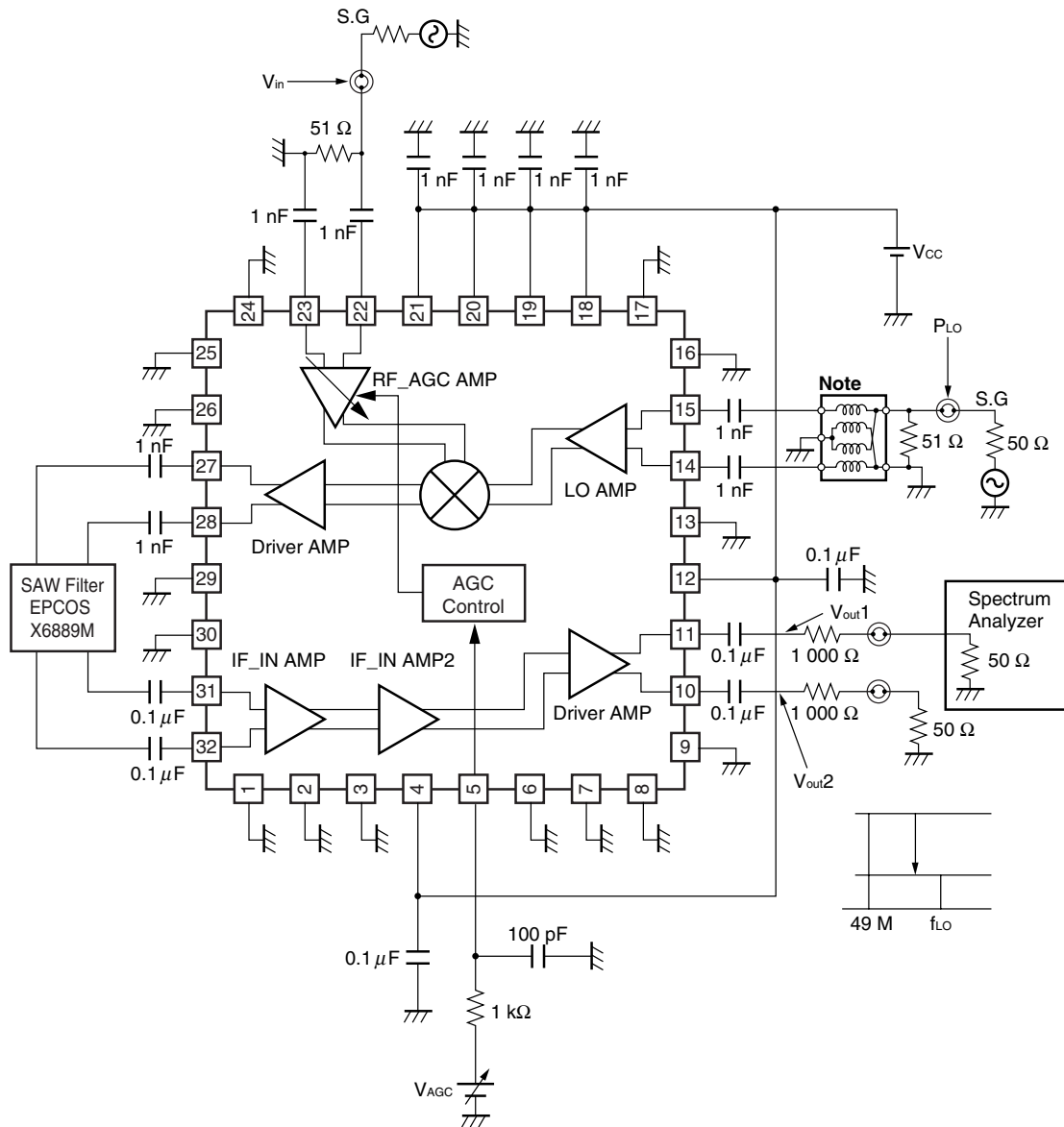


**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)

MEASUREMENT CIRCUIT 4

( $f_{RF} = 70$  to  $130$  MHz ( $f_{IF} = 49.1$  MHz  $\pm$  0.6 MHz),  $f_{LO} = 119$  to  $179$  MHz,  $P_{LO} = -10$  dBm,  $V_{out} = 0.7$  V<sub>p-p</sub> (Single Ended))

LO-IF Leakage

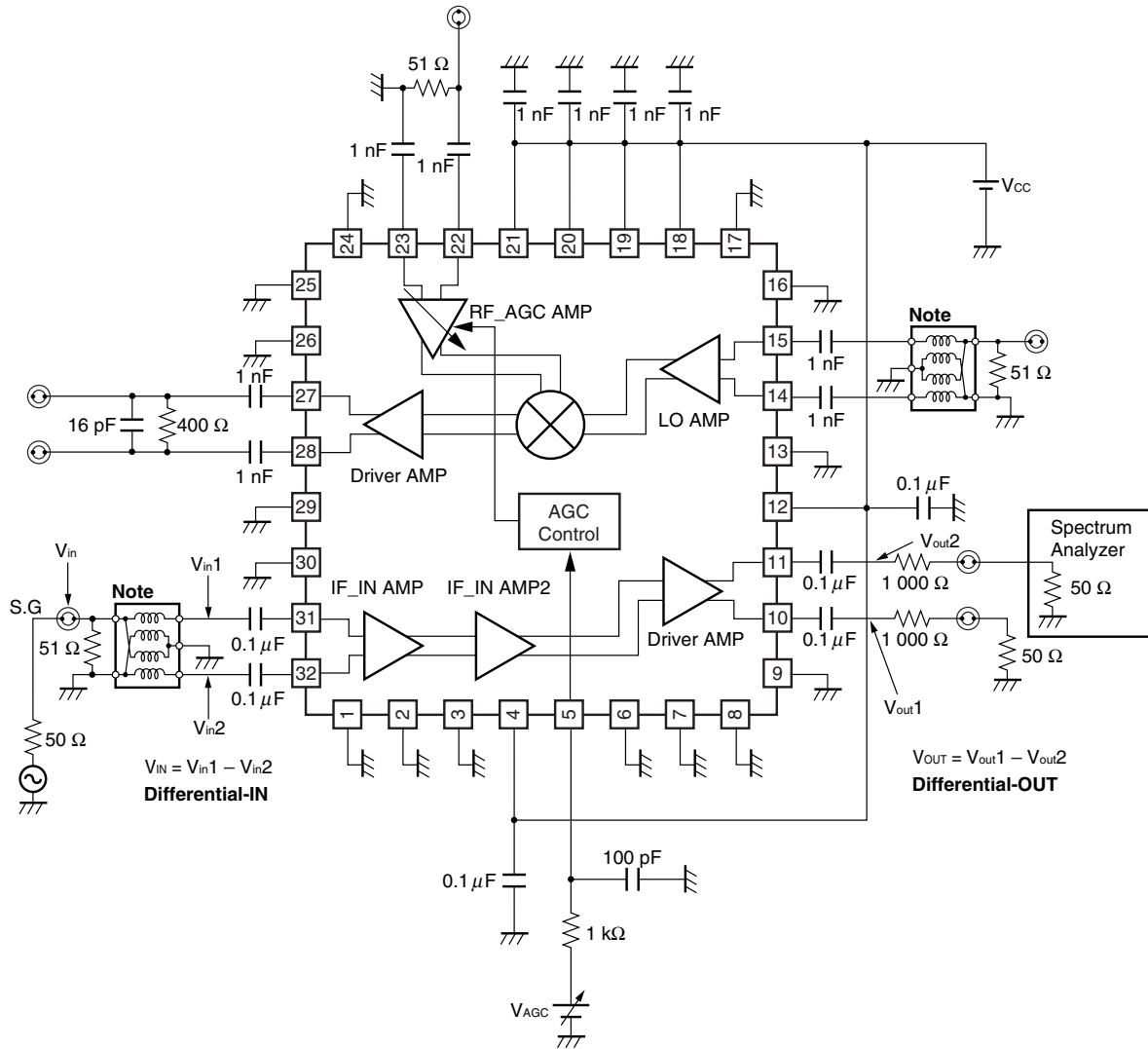


**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)



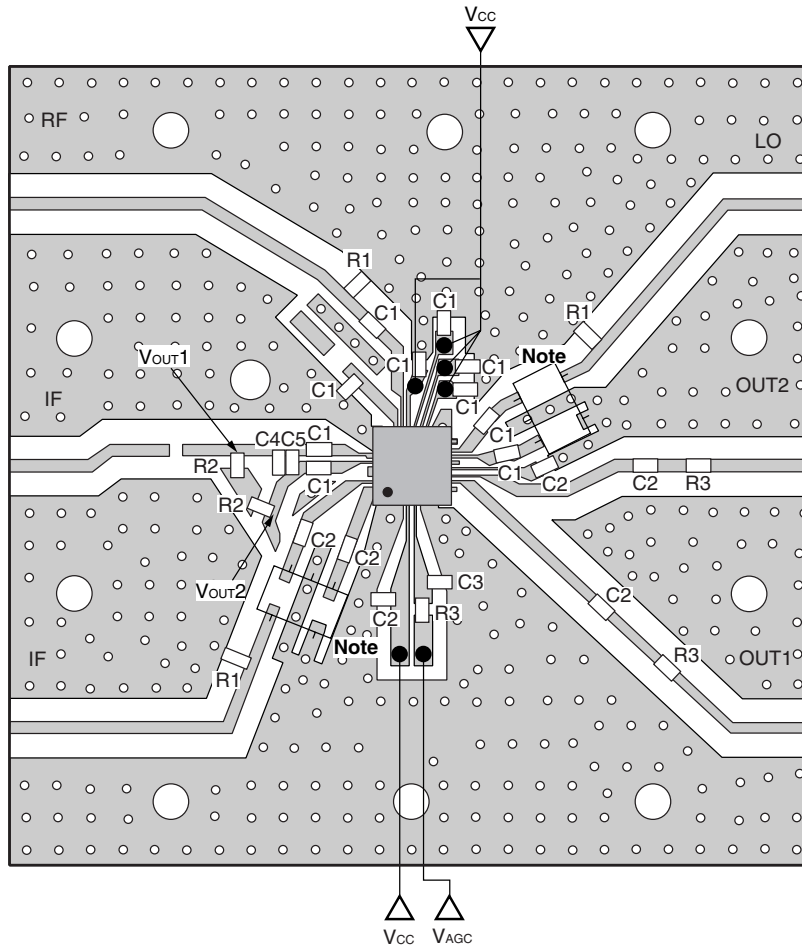
MEASUREMENT CIRCUIT 5

IF Block



**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)

ILLUSTRATION OF THE EVALUATION BOARD



**Note** Balun Transformer : TOKO 617DB-1674 B4F (Double balanced type)

**Remarks**

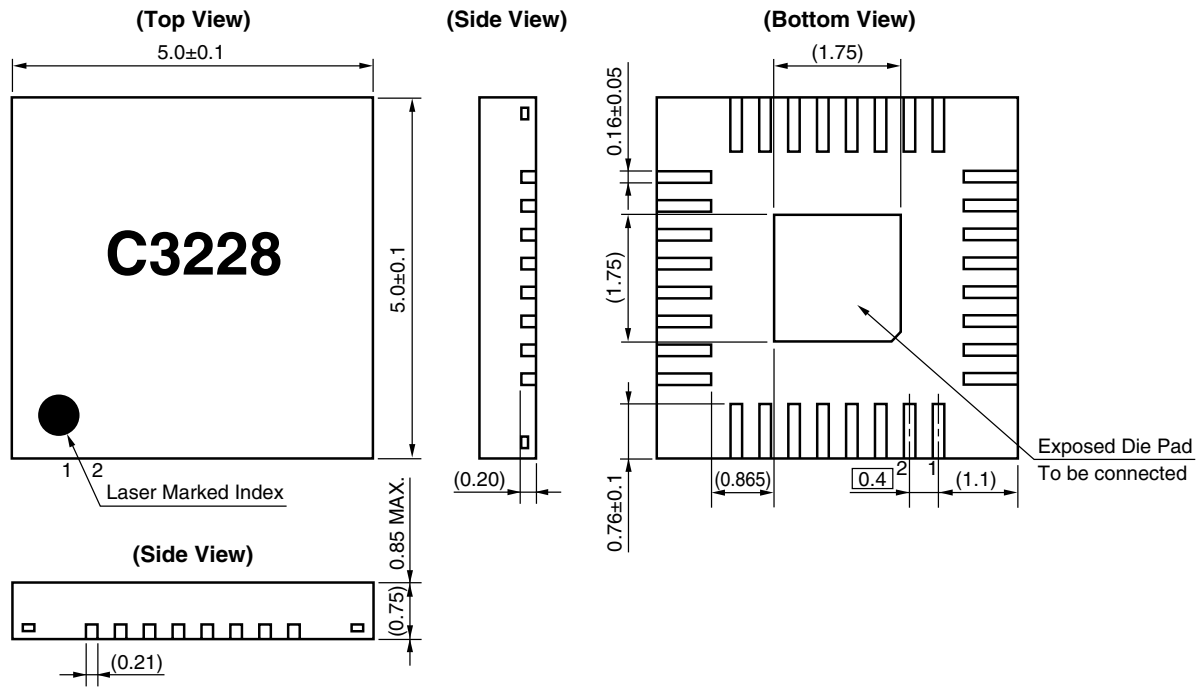
1. Back side: GND pattern
2. Solder plated on pattern
3. ○○ : Through hole

**USING THE NEC EVALUATION BOARD**

Symbol	Values	Maker	Part Number	Size
C1	1 nF	Murata	GRM39CH	1608
C2	0.1 μF	Murata	GRM39B	1608
C3	100 pF	Murata	GRM39CH	1608
C4	10 pF	Murata	GRM36B	1005
C5	6 pF	Murata	GRM36B	1005
R1	51 Ω	Susumu	RR0816 510SSM	1608
R2	200 Ω	Susumu	RR0816 201SSM	1608
R3	1 000 Ω	Susumu	RR0816 102SSM	1608

PACKAGE DIMENSIONS

32-PIN PLASTIC QFN (UNIT: mm)



**NOTES ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation).  
All the ground terminals must be connected together with wide ground pattern to decrease impedance difference.
- (3) The bypass capacitor should be attached to Vcc line.

**RECOMMENDED SOLDERING CONDITIONS**

This product should be soldered and mounted under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your nearby sales office.

Soldering Method	Soldering Conditions	Condition Symbol
Infrared Reflow	Peak temperature (package surface temperature) : 260°C or below Time at peak temperature : 10 seconds or less Time at temperature of 220°C or higher : 60 seconds or less Preheating time at 120 to 180°C : 120±30 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	IR260
Wave Soldering	Peak temperature (molten solder temperature) : 260°C or below Time at peak temperature : 10 seconds or less Preheating temperature (package surface temperature) : 120°C or below Maximum number of flow processes : 1 time Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (terminal temperature) : 350°C or below Soldering time (per side of device) : 3 seconds or less Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	HS350

**Caution Do not use different soldering methods together (except for partial heating).**

• **The information in this document is current as of June, 2006. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**

• No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Electronics. NEC Electronics assumes no responsibility for any errors that may appear in this document.

• NEC Electronics does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC Electronics products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Electronics or others.

• Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of a customer's equipment shall be done under the full responsibility of the customer. NEC Electronics assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.

• While NEC Electronics endeavors to enhance the quality, reliability and safety of NEC Electronics products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC Electronics products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.

• NEC Electronics products are classified into the following three quality grades: "Standard", "Special" and "Specific".

The "Specific" quality grade applies only to NEC Electronics products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of an NEC Electronics product depend on its quality grade, as indicated below. Customers must check the quality grade of each NEC Electronics product before using it in a particular application.

"Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

"Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).

"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

(1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.

(2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).

M8E 02.11-1

---

► For further information, please contact

**NEC Compound Semiconductor Devices Hong Kong Limited**

E-mail: [contact@ncsd-hk.necel.com](mailto:contact@ncsd-hk.necel.com)

Hong Kong Head Office TEL: +852-3107-7303 FAX: +852-3107-7309  
Taipei Branch Office TEL: +886-2-8712-0478 FAX: +886-2-2545-3859  
Korea Branch Office TEL: +82-2-558-2120 FAX: +82-2-558-5209

**NEC Electronics (Europe) GmbH** <http://www.eu.necel.com/>

TEL: +49-211-6503-0 FAX: +49-211-6503-1327

**California Eastern Laboratories, Inc.** <http://www.cel.com/>

TEL: +1-408-988-3500 FAX: +1-408-988-0279

**Compound Semiconductor Devices Division**

**NEC Electronics Corporation**

URL: <http://www.ncsd.necel.com/>